

Interaction of *Juglans* Species with *Phytophthora citricola*

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Abstract

Due to commercial interest in cultivating English walnut cultivars on their own roots rather than on typical rootstocks, we evaluated relative susceptibility to *Phytophthora citricola* on own-rooted cultivars Chandler and Vina and seedling rootstocks Northern California Black (NCB) and Paradox hybrid. In March 2003, dormant 1-year-old rootings of Vina and Chandler (originally from tissue culture) and comparable seedlings of NCB and Paradox hybrid were dug from a nursery and transplanted into 2-liter pots (one plant per pot) in a greenhouse. On May 15 and 28 (Experiments 1 and 2, respectively) 10 plants per walnut selection were inoculated with *P. citricola* (90 ml of V8 juice-vermiculite-oat substrate colonized by the pathogen was placed in the soil of each pot), and 10 plants per selection received sterile substrate as a control. All of the plants were flooded for 48 hours at biweekly intervals to facilitate disease development. Two to three months after inoculating, the plant root systems were washed free from soil to determine disease incidence and severity. There was no significant interaction between experiment and the treatment factors. The combined means for percent of crown length rotted by *P. citricola* on NCB, Paradox, Vina and Chandler was 89, 30, 59, and 82, respectively; whereas that on non-inoculated plants was 0 to 5. Percent of crown circumference rotted by *P. citricola* averaged 93, 24, 65, and 83 on NCB, Paradox, Vina and Chandler, respectively; but that on the controls was 0 to 6. For the crown rot variables, interaction between inoculation treatment and walnut selection was highly significant ($P=0.0001$ to 0.0005). The results suggest that under conditions highly conducive to disease, own-rooted 'Chandler' and 'Vina' and Northern California Black rootstock are highly susceptible to *P. citricola*, whereas Paradox offers marginal tolerance to the pathogen.

INTRODUCTION

Own-rooted English walnut cultivars propagated through tissue culture may have potential in areas where commonly used rootstocks of Northern California Black walnut (*Juglans hindsii*) and paradox hybrid (*J. hindsii* × *J. regia*) are undesirable because they are hypersensitive to cherry leafroll virus, the cause of walnut blackline disease. English walnut is tolerant of strains of the virus found in California. Another advantage of own rooted English walnut trees propagated by tissue culture is that they cost less to purchase than nursery-grafted trees. However, in a previous field study, some own-rooted English walnut trees of cultivar 'Chandler' suffered from dieback and low vigor associated with damage caused by the lesion nematode, *Pratylenchus vulnus* (Hasey et al., 2004).

Although seedling rootstock of *J. regia* is considered to be highly susceptible to *Phytophthora* spp. (Matheron and Mircetich, 1985; Mircetich et al., 1998), the susceptibility of own-rooted English walnut cultivars to *Phytophthora citricola*, an important cause of crown rot on California walnuts, had not been explored. The objective of this study was to determine relative susceptibility to *Phytophthora citricola* among micro-propagated own-rooted English cultivars 'Chandler' and 'Vina' and seedling rootstocks Northern California black (*J. hindsii*) and Paradox hybrid (*J. hindsii* × *J. regia*).

MATERIALS AND METHODS

Tissue cultured own-rooted 'Chandler' and 'Vina' imported from Spain were selected for uniformity in September 2002 after growing one season in a California nursery. The selected dormant 1-year-old rootings of each cultivar and comparable seedlings of the rootstocks Northern California black and Paradox were dug from the nursery and transplanted into 2-liter pots (one plant per pot) in a greenhouse in March 2003.

The potted plants were subjected to inoculations and intermittent soil flooding in two greenhouse experiments. Experiment 1 began with inoculation on May 15, 2003, and Experiment 2, a repeat of the first test, began on May 28, 2003. In each experiment, inoculum of *P. citricola*, grown and carried on a V8 juice-oat-vermiculite substrate (V8OV; Matheron and Mircetich, 1985), was mixed into the surface soil around 10 plants per walnut selection (90 ml of inoculum substrate per pot). A mixture of four isolates of *P. citricola* was used (gb1572, gb572, gb1281, and gb579, all from walnut in California).

The surface soil around another 10 of the potted plants per walnut selection received sterile V8OV as a control (90 ml per pot). In both experiments, there were five replicate two-plant plots per treatment combination of inoculum and rootstock, arranged on greenhouse benches in randomized complete blocks. Within 1 week after transplanting, and every other week thereafter, all of the plants were subjected to 48-h episodes of soil flooding to facilitate disease development. On July 24 and August 14 (Experiments 1 and 2, respectively), the top of each plant was removed at about 2 cm above the soil surface, and each root system was washed free from soil. For each root system, the length of the root crown and the percentage of the root crown that was rotted were measured. In addition, the percent of the root crown girdled with necrosis and the percentage of the roots that were visibly necrotic were estimated.

Data were subjected to a two-way analysis of variance using PROC MIXED of SAS Version (SAS Institute, Inc., Cary, NC). The treatment means were separated according to 95% confidence intervals.

RESULTS AND DISCUSSION

For all measured disease variables, there were no significant main or interactive effects of experiment ($P=0.1488$ to 0.9417). Therefore, the data from Experiments 1 and 2 were combined for separation of means and presentation here.

Crown Rot

The two own-rooted English cultivars and Northern California black rootstock developed severe crown rot (Table 1). In contrast, Paradox rootstock developed significantly less crown rot than the other walnut selections. Only negligible crown rot developed in the non-inoculated controls (0 to 6%).

Root Rot

Northern California black rootstock developed severe root rot (92%) whereas the other inoculated and non-inoculated walnut selections developed negligible to mild root rot (7 to 24%) (Table 1).

Observational Data

Lenticel hypertrophy (Kozlowski, 1984) in response to the flooding was observed on the crowns or larger roots of all tested walnut selections, particularly on the own-rooted cultivars. Some of the plants also produced adventitious roots in response to the flooding (Kozlowski, 1984). Although the own-rooted cultivars had extensive crown rot, they did not express extensive leaf yellowing or collapse as did the Northern California black rootstock.

CONCLUSIONS

Our results suggest that own-rooted English walnut cultivars 'Vina' and 'Chandler' are highly susceptible to crown rot caused by *P. citricola*, as is true for

Northern California black walnut rootstock. Growers should avoid planting these cultivars on their own roots in soil infested with *P. citricola*. In contrast, Paradox offers partial tolerance to *P. citricola*. These results are consistent with previous field and greenhouse findings that English and black walnut seedlings are highly susceptible and Paradox rootstock is relatively tolerant to several *Phytophthora* spp. (Matheron and Mircetich, 1985, Mircetich et al., 1998).

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Literature Cited

- Hasey, J.K., Westerdahl, B.B. and Lampinen, B. 2004. Long-term performance of own-rooted 'Chandler' walnut compared to 'Chandler' walnut on Paradox rootstock. *Acta Hort.* (ISHS) 636:83-87.
- Kozlowski, T.T. 1984. *Flooding and Plant Growth*. Academic Press, Inc., Orlando, Florida.
- Matheron, M.E. and Mircetich, S.M. 1985. Relative resistance of different rootstocks of English walnut to six *Phytophthora* spp. that cause root and crown rot in orchard trees. *Plant Disease* 69: 1039-1041
- Mircetich, S.M., Browne, G.T., Matheron, M.E. and Teviotdale, B.L. 1998. Armillaria and Phytophthora root and crown diseases. Pages 221-232 in: *Walnut Production Manual*, D.E. Ramos, Ed.. University of California, Division of Agriculture and Natural Resources, Oakland, CA. Publication 3373.

Tables

Table 1. Relative resistance to *Phytophthora citricola* among own-rooted English walnut cultivars and seedling rootstocks for walnut¹.

Treatment	Rootstock	% Crown Length Rotted	% Crown Circum. Rotted	% Root Rot
<i>P. citricola</i>	OR ² Chandler	82 a	83 a	24 a
	OR Vina	59 a	65 a	18 a
	Paradox	30 b	24 b	16 a
	NCB ³	89 a	93 a	92 b
Non-inoculated	OR Chandler	0 c	0 b	13 a
	OR Vina	5 bc	6 b	10 a
	Paradox	0 c	0 b	7 a
	NCB	0 c	0 b	21 a

¹ The effect of inoculum x walnut selection was highly significant for each variable ($P \leq 0.0001$ to 0.0007). Means followed by the same letter in a column are not significantly different (based on 95% confidence intervals).

² Own-rooted

³ Northern California black